Supplementary Online Content


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This supplementary material has been provided by the authors to give readers additional information about their work.
eFigure 1. Study Design

Continuous enrollment (6 months) → 180 days → 180 days → Follow-up (Censored at switch or disenrollment) → Fracture

10 non-treated episodes matched for each treated

Cohort entry date: Hospitalization with Hip fracture

Osteoporosis prescription

No osteoporosis Medication use
eFigure 2. Proportion of Patients Receiving Treatment With Osteoporosis Medications by Instrumental Variable Strata

**IV1: Calendar year**

**IV2: Specialist access**

**IV3: Geographic variation**

**IV4: Provider preference**

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eFigure 3. Cumulative Regression Function With Pointwise 95% Confidence Interval for the Treatment Effect Under the Additive Hazard Model
### eTable. Components of the Composite Outcome

<table>
<thead>
<tr>
<th>Fracture</th>
<th>Definition/codes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Humerus</strong></td>
<td>Humerus fracture diagnosis (ICD-9: 812.xx, 733.11) AND procedure within 30 days of fracture date (ICD-9: 78.52, 79.01, 79.11, 79.21, 79.31, 79.61; CPT-4: 23600, 23605, 23610, 23615, 23620, 23625, 23630, 23665, 23670, 23680, 24500, 24505, 24506, 24510, 24515, 24530, 24531, 24535, 24536, 24538, 24540, 24542, 24545, 24560, 24565, 24570, 24575, 24581, 24583, 24585-8, 24516)</td>
</tr>
<tr>
<td><strong>2. Radius and/or Ulna</strong></td>
<td>Radius/ulna fracture diagnosis (ICD-9: 813.xx, 733.12) AND procedure within 30 days of fracture date (ICD-9: 78.53, 79.02, 79.12, 79.22, 79.32, 79.62; CPT-4: 24620, 24625, 24635, 24650, 24655, 24660, 24665-6, 24670, 24680, 24685, 25500, 25505, 25510, 25515, 25530, 25535, 25540, 25545, 25560, 25565, 25570, 25575, 25600, 25605, 25610-1, 25615, 25620, 25650)</td>
</tr>
<tr>
<td><strong>4. Pelvis</strong></td>
<td>Pelvis fracture diagnosis (ICD-9: 808.xx)</td>
</tr>
</tbody>
</table>

Codes used for identification of confounding variables: Osteoporosis diagnosis (ICD-9-CM codes 733.0x), presence of bone mineral density test (CPT code 77080, 77085), Parkinson’s disease (ICD-9-CM codes 332.xx or 333.0x), Alzheimer’s disease or other dementia (ICD-9-CM codes 290.xx, 294.xx, 330.xx, 331.xx), obesity (ICD-9-CM codes 278.0x, 649.1x, V85.3x, V85.4x), diabetes mellitus (ICD-9-CM codes 250.xx), rheumatoid arthritis (ICD-9 codes 714.x), or history of falls, syncope, or gait abnormality (ICD-9-CM codes E885, E885.9x, E888.xx, 780.2x, 458.0x, 781.2x, 782.3x)
eAppendix. Model Equations

1. **Mixed effect models for calculating adjusted rates of treatment for creating geographic and provider preference IVs**

   \[
   \text{logit} \left( P(Y_{ij} = 1|\text{Age}_i, \text{Gender}_i, \text{Random effect}_j^*) \right) = \beta_0 + \beta_1 \text{Age}_i + \beta_2 \text{Gender}_i + \beta_3 j
   \]

   * MSA Region was the random variable for IV3 and Primary provider was the random variable for IV4

   \( Y_{ij} \) = treatment initiation status in individual i in region j (or with provider j)

   \( \beta_0 = \text{Fixed intercept} \)

   \( \beta_1 = \text{Age co-efficient} \)

   \( \beta_2 = \text{Gender co-efficient} \)

   \( \beta_3 j = \text{Random intercept specific to region j (or provider j)} \)

2. **First stage instrumental variable models**

   \[
   \Pr(A_i = 1|IV = IV_i, X = x_i) = \frac{\exp(\beta_0 + \beta_1 IV_i + \sum_{k=2}^{n} \beta_k x_{k,i})}{1 + \exp(\beta_0 + \beta_1 IV_i + \sum_{k=2}^{n} \beta_k x_{k,i})}
   \]
\[ \text{Pr}(A_i = 1|IV = IV_i, X = x_i) = \text{Probability of osteoporosis medication initiation given covariates and instrumental variable values for each individual } i \]

\[ \beta_0 = \text{Intercept} \]
\[ \beta_1 = \text{IV co-efficient} \]
\[ \beta_k = \text{Co-efficients (}\beta_2 \text{ through } \beta_n\text{) for predictor variables} \]
\[ x_{k,i} = \text{Covariate values for individual } i \]

3. **Second stage instrumental variable model (Additive hazards model)**

\[ h(t|A, X) = h_0(t) + \beta_1(t)A + \beta_2(t)\Delta + \sum_{k=3}^{n} \beta_k(t)x_k \]

\[ h_0(t) = \text{baseline hazard} \]
\[ \beta_1 = \text{Treatment effect estimate} \]
\[ A = \text{Actually received treatment} \]
\[ \beta_2(t)\Delta = \text{Control function which is meant to capture variation in the hazard function due to unobserved correlates of the treatment;} \]
\[ \text{where } \Delta = A - \Pr(A_i = 1|IV = IV_i, X = x_i) \]
\[ \beta_k = \text{Co-efficients for other covariates in the model} \]